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TITLE: REVENUE METER BAYONET ASSEMBLY AND METHOD OF ATTACHMENT

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REVENUE METER BAYONET ASSEMBLY AND METHOD OF ATTACHMENT

RELATED APPLICATIONS

The following co-pending and commonly assigned U.S. patent applications have been filed on the same date as the present application. All of these applications relate to and further describe other aspects of the embodiments disclosed in the present application and are all herein incorporated by reference.

U.S. Patent Application Serial No. 09/370,317, "REVENUE METER WITH POWER QUALITY FEATURES", (Attorney Ref. No. 06270/22), filed August 9, 1999.

U.S. Patent Application Serial No. 09/371,883, "A-BASE REVENUE METER WITH POWER QUALITY FEATURES", (Attorney Ref. No. 06270/32), filed August 9, 1999

U.S. Patent Application Serial No. 09/370,695, "REVENUE METER WITH A GRAPHIC USER INTERFACE", (Attorney Ref. No. 06270/23), filed August 9, 1999.

U.S. Patent Application Serial No. 09/370,863, "A POWER SYSTEM TIME SYNCHRONIZATION DEVICE AND METHOD FOR SEQUENCE OF EVENT RECORDING", (Attorney Ref. No. 06270/24), filed August 9, 1999.

U.S. Patent Application Serial No. 09/369,870, "METHOD AND APPARATUS FOR AUTOMATICALLY CONTROLLED GAIN SWITCHING OF POWER MONITORS", (Attorney Ref. No. 06270/27), filed August 9, 1999.

U.S. Patent Application Serial No. 09/370,696, "EXTERNAL COMMUNICATIONS INTERFACE FOR A REVENUE METER", (Attorney Ref. No. 06270/26), filed August 9, 1999.

U.S. Patent Application Serial No. 09/370,752 "A KEYPAD FOR A REVENUE METER", (Attorney Ref. No. 06270/34), filed August 9, 1999

BACKGROUND OF THE INVENTION

This invention relates to a connector for a circuit board and more particularly to a connector for a circuit board used in electrical meters, for example, revenue meters of the type used by energy suppliers to accurately measure electrical energy delivered to customers for the purposes of billing and/or collecting revenue, and power quality meters having power quality monitoring, detection, quantification and reporting capabilities.

In a typical electrical distribution system, electrical energy is generated by an electrical supplier or utility company and distributed to customers via a power distribution network. The power distribution network is the network of electrical distribution wires which link the electrical supplier to its customers. Typically, electricity from a utility is fed from a primary substation over a distribution cable to several local substations. At the substations, the supply is transformed by distribution transformers from a relatively high voltage on the distributor cable to a lower voltage at which it is supplied to the end customer. From the substations, the power is provided to industrial users over a distributed power network that supplies power to various loads. Such loads may include, for example, various power machines.

At the customer's facility, there will typically be an electrical energy meter ("revenue meter") connected between the customer and the power distribution network so as to measure the customer's electrical demand. The revenue meter is an electrical energy measurement device, which accurately measures the amount of electrical energy flowing to the customer from the supplier or from the customer to the supplier. The amount of electrical energy measured by the meter is then used to determine the amount for which the energy supplier should be compensated. Typically, revenue meters are

socket-based meters. That is, revenue meters will generally be of an A-base or S-base meter, as described in more detail below. Alternatively, revenue meters may also be of the switchboard type, as described in more detail below.

The ANSI standards define two general types of revenue meters, socket based ("S-base" or "Type S") and bottom connected ("A-base" or "Type A"). These types of revenue meters are distinguished by the method by which they are connected to the electric circuit that they are monitoring. This invention pertains to S-base meters. S-base meters feature electrically-conducting bayonets (blade type terminals) disposed on back side of the meter. These electrically-conducting bayonets are designed to align with matching jaws of a detachable meter mounting device such as a revenue meter socket. The socket is hard wired to the electrical circuit and is intended to be installed in a permanent manner. To install an S-base meter, the utility need only plug in the meter into the socket. This makes installation of new meters and especially replacement of defective meters extremely simple. Once installed, the installer need only secure the sealing means, which ensure that the meter will not be tampered with (as detailed in the ANSI standards). To remove the meter, the installer need only pull it out of the socket.

The relevant ANSI standards specify the exact physical and electrical requirements of the blade terminals for the S-base meter. Further, these standards also specify requirements common to both types of meters. These include durability and operating lifetime requirements. They further include requirements for physically sealing the meters. Revenue meters must provide sealing mechanisms to both protect the meter from environmental conditions existing in the installed location as well as protect the meter from unauthorized tampering. Typically, revenue meters are contained entirely within a housing which features a meter cover usually made of a transparent material. Typically, this includes the meter electronics, voltage transformer (PT), current transformer (CT), meter display and user interface as specified by the ANSI standards. It should be noted however, that in certain high

voltage applications, other CT and PT's can be located remote from the revenue meter and connected with the meter's internal CT and PT's via the S-base or A-base connection in order to isolate dangerous high voltage signals from the meter. For a more detailed description of revenue meters, the reader is referred to the co-pending applications referred to in the first paragraph of this disclosure, which are all incorporated herein by reference.

The present invention simplifies the assembly of the connector between the bayonets or blades and the circuit board. That is, prior to this invention, electrically conducting bayonets were traditionally held in place by cotter pins. A wire harness which was soldered to each individual bayonet was used to connect the bayonets to the measuring circuitry of the meter. Inserting the cotter pins and soldering the wiring harness to the individual bayonets is time consuming since it introduces additional manufacturing steps.

Therefore, it is an object of the present invention to simplify the manufacturing process for attaching bayonets to an S-type revenue meter base by soldering the bayonets directly into a printed circuit board, mounting the printed circuit board on the base, thereby eliminating the need for cotter pins and a wiring harness.

SUMMARY OF THE INVENTION

Accordingly, the present invention provides a method and apparatus for attaching one or more electrical bayonet-type blades to a circuit board. The arrangement comprises a circuit board with at least one opening adapted to receive one blade. Preferably, a solder pad is disposed on at least one surface of the board and surrounds the opening. A plurality of vias surround the opening. In the embodiment using the soldering pad, the vias are arranged within the solder pad. Solder is applied around the electrically conducting bayonet on one surface of the circuit board, through the vias, and around the electrically conducting bayonet to the opposite surface of the circuit board.

This method can be used to fabricate a connection device using fewer manufacturing steps.

BRIEF DESCRIPTION OF SEVERAL VIEWS OF THE DRAWINGS

FIG. 1 shows a front perspective view of a preferred embodiment of a connector device of the present invention;

FIG. 2 shows a cross section of the connector device of FIG. 1;

FIG. 3 shows a back perspective view of the connector device of FIG. 1;

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~~FIGS. 4A and 4B show an enlarged view and a cross-sectional view of an opening in the circuit board of FIG. 1, respectively;~~

FIG. 4C shows an enlarged cross sectional view of an opening in the circuit board of FIG. 1, with a bayonet mounted in the opening;

FIG. 4D shows an enlarged cross sectional view of an opening in the circuit board of FIG. 1, with a bayonet mounted in the opening and solder in the connection;

FIG. 5 shows a revenue meter incorporating a circuit board using the connector device of the present invention; and

FIG. 6 is a bottom perspective view of the meter of FIG. 5.

DETAILED DESCRIPTION OF THE INVENTION

Overview

Referring now to Figure 5 and Figure 6, S-base meters feature blade type terminals 14a, 14b and 14c disposed on backside of the meter. In the embodiment illustrated, the meter 30 includes a row of bayonet or blade terminals 14a and a row of terminals 14b used as current terminals. The meter 30 also includes a row of bayonets 14c which are used in this embodiment as voltage terminals. It will be recognized by those skilled in the art that in other embodiments the blades may be used in other arrangements. For example, depending on the form factor, the bayonets 14b may be used as voltage terminals. The bayonets 14a, 14b and 14c may be used in any other suitable combination of voltage and current terminals or for other purposes.

The bayonet terminals 14a, 14b and 14c are designed to mate with matching jaws of a detachable meter-mounting device, such as a revenue meter socket 37. The socket 37 is hard wired to the electrical circuit and is not meant to be removed. A socket-sealing ring 39 is used as a seal between the meter 30 and the meter socket 37 to prevent removal of the meter and to indicate tampering with the meter. To install an S-base meter, the utility need only plug in the meter into the socket. This makes installation of new meters and especially replacement of defective meters extremely simple. Once installed, the installer need only secure the sealing ring ~~37~~ 39, which ensures that the meter will not be tampered with (as detailed in the ANSI standards). To remove the meter 30, the installer need only pull it out of the socket 37. The meter includes a cover 31. In an exemplary embodiment, the cover 31 is made of a clear material. The meter 31 also includes a communications port 40, and a graphic user interface, which includes buttons 34a, 34b, and 34c and a display screen 32.

Preferred embodiments

According to one aspect of the present invention, there is provided a connector device comprising a circuit board with at least one opening adapted to receive a bayonet-type electrically conductive blade. Preferably, a solder pad, disposed on at least one side of the circuit board, surrounds the opening. A plurality of vias surrounds the opening and are disposed such that they pass through the solder pad. Vias are thru-holes, preferably plated, that are typically used to provide an electrical connection between layers on a printed circuit board. For purposes of the present invention the vias extend through the board forming a passage between the surfaces of the board. An electrically conducting bayonet is mounted on the circuit board through the opening. The bayonet is attached to the circuit board by solder which surrounds the bayonet on one surface of the circuit board, extends through the opening and plurality of vias and surrounds the bayonet on the opposite surface of the circuit board.

Preferably the bayonets are spaced on the circuit board in a pattern such that the connector device is complementary for use with a socket which is hard wired to the electrical circuit. In such an embodiment, the connector device is designed such that the bayonets align with an aperture on the socket so as to insert therein. Once inserted into the socket, the power supply attached to the socket can be used to supply power to the device. The bayonets are used to receive supply signals to the circuit board (i.e. voltage, current, etc.).

FIG. 1 shows a front perspective view of a connector device comprising a circuit board 11, at least one, and preferably a plurality of, electrically conducting bayonets 14, and an electrical component surrounded by a housing 13. The circuit board 11 is preferably a multi-layered printed circuit board. To improve structural soundness, the circuit board is preferably no less than 0.100 inches thick.

FIG. 2 shows a cross section of a connector device comprising a circuit board 11, two electrically conducting bayonets 14a and 14b, and an electrical component 12 surrounded by a housing 13. In the illustrated embodiment, one of the electrically conducting bayonets 14a straddles the electrical component 12. It will be recognized by those skilled in the art that it is not necessary for the bayonets 14a to straddle the electrical component 12. However, the straddling arrangement adds structural stability to the arrangement. The electrically conducting bayonets 14a and 14b are electrically connected via an electrical connection 15, as described in more detail below. As illustrated, the circuit board includes a plurality of bayonets 14a arranged in a first row on the circuit board and a plurality of bayonets 14b arranged in a second row on the circuit board. Each bayonet in a pair of bayonets 14a and 14b are electrically connected to each other. These two rows of bayonets 14a and ~~4b~~ 14b may be used, for example, in conjunction with a current transformer. For applications using devices which sense current (i.e. a current transformer) the two bayonets 14a and 14b need to be connected (one as an input blade and one as a return blade). As electricity flows from the power supply through the circuit formed by the electrical connection 15 and

e electrically conducting bayonets 14a and 14b, a magnetic field is induced. This induced field can then be detected by the electrical component 12, which is for example a current transformer.

As shown in the figures, the circuit board may also include a set of blades 14c arranged in a row on the circuit board. Each of the bayonets 14c may be used for a supply signal that is a voltage signal.

One distinct advantage of the present device is that by mounting the electrical component 12 with a straddling electrically conducting bayonet 14a, one eliminates the need for other elaborate mounting schemes.

The electrical component 12 is preferably surrounded by a housing 13, which insulates the component from direct contact with the bayonet 14a that carries electric current. The housing can be made of any insulating material, and is preferably plastic. By enclosing the electrical component 12 in a housing 13, one can ensure adequate insulation between the electrically conducting bayonets 14a and the electrical component 12, for example, a current transformer's secondary windings.

FIG. 3 shows a back view of a connector device comprising a circuit board 11, a plurality of electrically conducting bayonets 14. Pairs of electrically conducting bayonets 14a and 14b are electrically connected via an electrical connection 15. The electrically conducting bayonets 14 are inserted through openings in the circuit board 11.

The electrical connection 15 is preferably located within the circuit board 11; for example, between layers of a multi-layered printed circuit board. By so locating the electrical connection 15, one can avoid problems that would otherwise arise if the electrical connection were located externally, in proximity to the electrically conducting bayonets 14.

The preferred type of electrical connection is an electrical trace, especially a copper trace. The trace may be formed on the surface of the circuit board. Preferably, however, the trace is formed on the inner layers of the circuit board. The bond between the copper and the fiberglass layers introduces strength to the connector. Adequate copper thickness and width of current traces need to be maintained to ensure sufficient current carrying

capacity. Preferably, multiple redundant traces are run on separate inner layers of the multi-layered printed circuit board to improve current carrying capacity. It will be recognized by those skilled in the art that the connection between two bayonets may comprise other suitable connections. For example, the connection 15 may be a wire or a bar connecting the two bayonets.

FIG. 4A shows an enlarged view of an opening 16 in the circuit board 11. The opening 16 is surrounded by a plurality of vias 17. The size of the opening 16 is formed to be slightly larger than the size of the bayonet to be received in the opening 16. Thus, a small gap is defined between the blade and the inner surface of the opening 16. As explained below, the gap between the wall of the opening and the outer wall of the bayonet leaves a gap for solder to flow up through.

FIG. 4B shows a cross section of the circuit board 11 through the opening 16. The vias 17 provide channels surrounding the opening 16 that open to both the top and bottom side of the circuit board. Preferably, a solder pad 18 is formed around the opening 16, on at least one side and preferably on both sides of the circuit board 11. An electrically conducting bayonet 14 is adapted to be inserted into the opening 16.

Referring now to FIGS. 4B and 4C, the opening 16 is preferably coated or plated with copper, illustrated by the dark lines 16a in FIGS. 4B and 4C. This coating is referred to as thru-hole plating. As illustrated by the dark line in the figure, the vias 17 are also coated with thru-hole plating 17a, preferably also made of copper.

To assemble the blades to the circuit board, a blade 14 is inserted, as illustrated in FIGS. 4C and 4D, in the opening 16. Solder is then applied to the circuit board from one side such that it flows through the gap defined between the opening 16 and the bayonets 14 and through the vias 17. Preferably, the solder flows through the gap to both sides of the circuit board 11 (i.e. to the soldering pads on the surfaces of the circuit board) and through the vias 17 to both sides of the circuit board 11. After the solder cools, a copper coating-solder-blade bond is formed on the inside walls of the opening

16. Preferably, as stated above, the vias also have thru-hole plating to permit the solder to flow up through the vias 17. Once cooled, the solder fills the vias 17, forming a structural bond. FIG. 4D illustrates the bayonet inserted through the opening 16 with solder filling the gap between the opening 16 and the bayonet and also filling the vias 17.

The solder pad(s) 18 may be formed on the surfaces of the circuit board in a manner known in the art. For example, the entire circuit board may be covered with the solder pad material and then the material may be selectively etched away leaving only the pad(s) formed on the circuit board.

The vias can be of any size, but are preferably about 0.018" to 0.100" wide. It will be recognized that the width of the vias is affected by the thickness of the circuit board 11. Functionally, the size of the via must be large enough so that the solder can flow up it and fill the hole after the solder cools, but must be small enough so that the solder does not fall back out of the hole and leave it empty. Typically, the opening 16 is surrounded by at least 2 vias, preferably more than 10 vias. By applying solder through these vias 17, the mechanical strength of the connection of the electrically conducting bayonet to the circuit board is improved.

It will be recognized by those skilled in the art that other methods of attaching the blades using solder may also be used. For example, although it is preferable to use the thru-hole plating in the opening 16, the thru-hole plating can be eliminated if the space between the bayonet and the inside walls of the opening is made large enough. If the gap is large enough, the solder can flow up, through the gap and form a bond with the bayonet and the solder pad 18 on the opposite side from where it originally flowed up through.

Also, it is possible to omit the soldering pad 18 and add solder in another step. For example, the end of the bayonet that is to be inserted into the opening may be dipped into a solder pot and the solder allowed to cool and form a coating. Then a blade is inserted into the opening 16 and the bayonet/board is heated to permit reflow without applying more solder. The solder on the end of the bayonets will reheat and reflow forming a bond.

Also, it is possible to attach the bayonet 14 through the thru-hole without the use of the vias 17. In this embodiment, the solder through the gap formed between the opening and the outer wall of the bayonet would form the attaching structure.

The solder arrangement of this invention can also be used to solder other modules, such as transient suppression devices and the like, to the circuit board 11.

A wave solder machine is preferably used to solder the electrically conducting bayonets to the circuit board. The wave solder machine is used to pass solder through the channels created by the vias 17 through to the opposite side of the circuit board 11.

It is to be understood that a wide range of changes and modifications to the embodiments described above will be apparent to those skilled in the art, and are contemplated. It is therefore intended that the foregoing detailed description be regarded as illustrative rather than limiting, and that it be understood that it is the following claims, including all equivalents that are intended to define the spirit and scope of this invention.